



# The Low Power Option – Some Consequences for ILC Physics

Chris Damerell, Sonja Hillert and Tim Woolliscroft  
RAL, Oxford U and Liverpool U



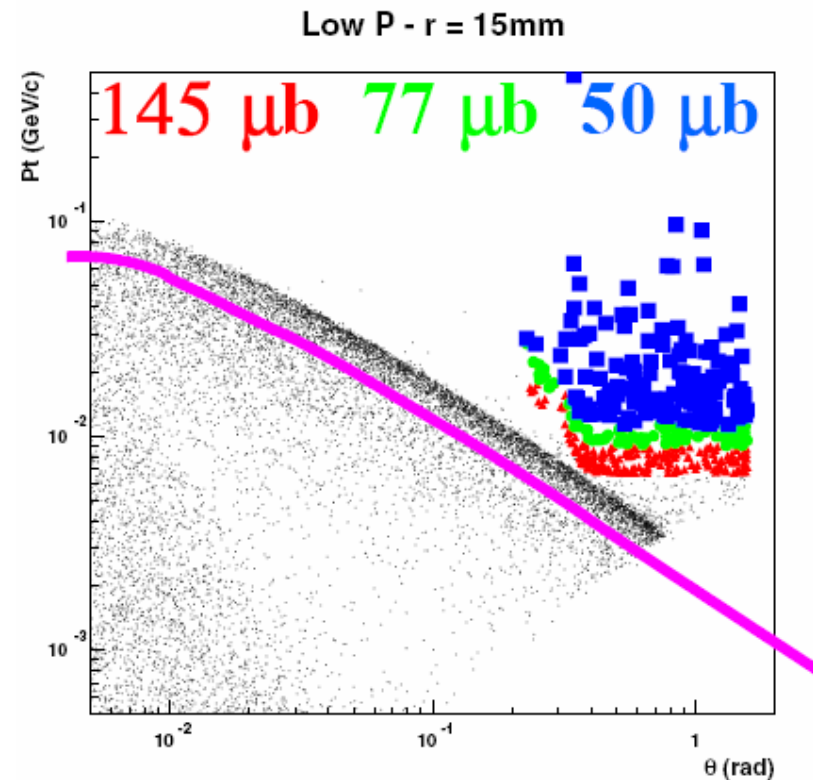
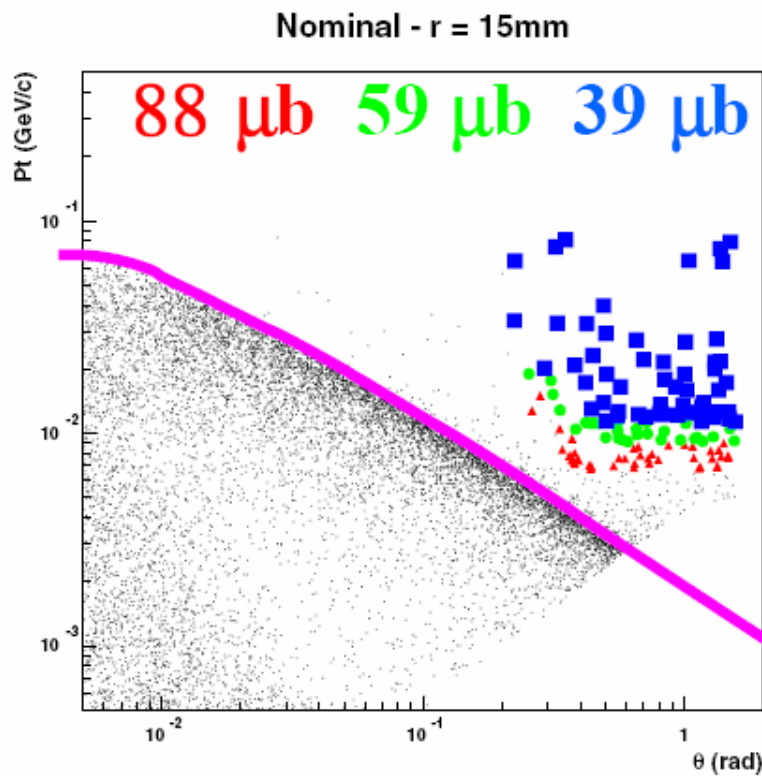
# Example Parameter Sets

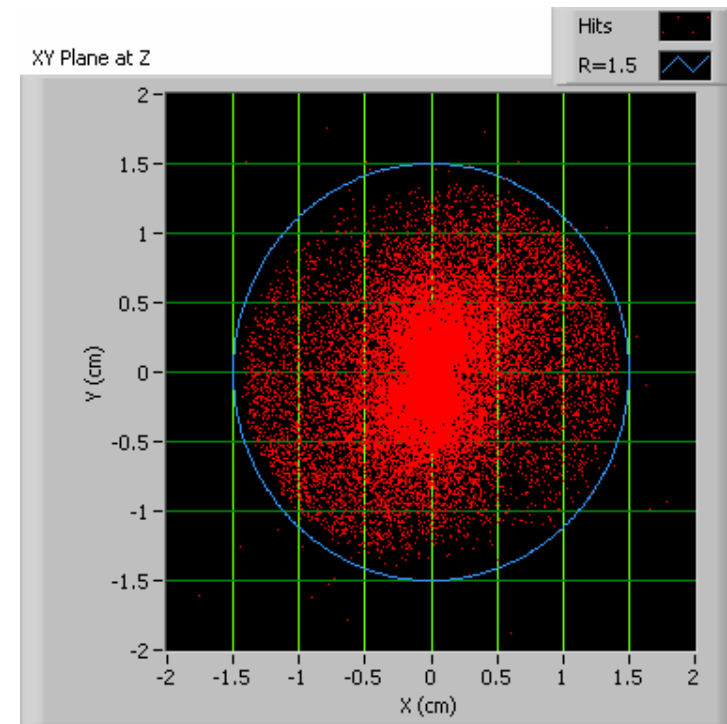
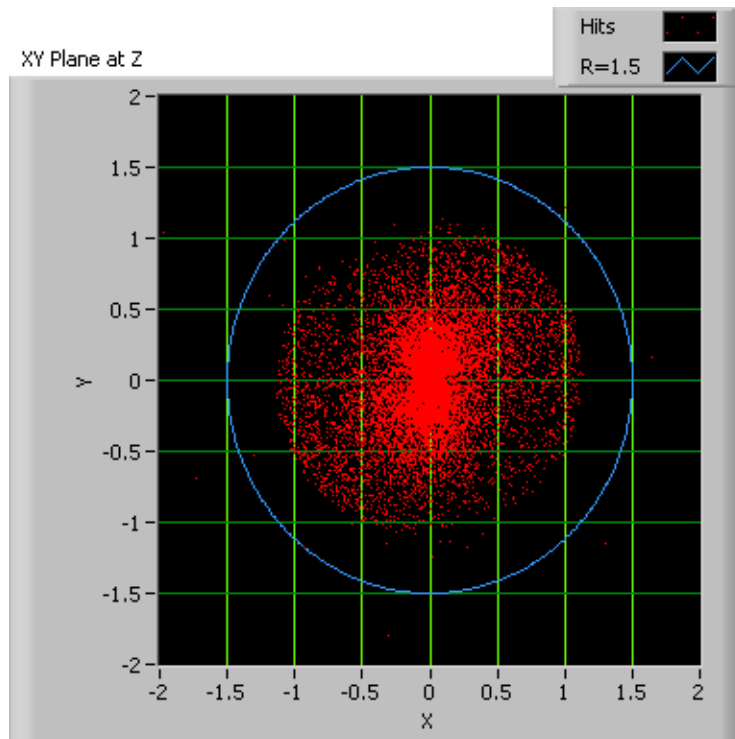
		<b>nom</b>	<b>low N</b>	<b>lrg Y</b>	<b>low P</b>	<b>High L</b>
$N$	$\times 10^{10}$	2	1	2	2	2
$n_b$		2820	5640	2820	1330	2820
$\epsilon_{x,y}$	$\mu\text{m}, \text{nm}$	9.6, 40	10, 30	12, 80	10, 35	10,30
$\beta_{x,y}$	cm, mm	2, 0.4	1.2, 0.2	1, 0.4	1, 0.2	1, 0.2
$\sigma_{x,y}$	nm	543, 5.7	495, 3.5	495, 8	452, 3.8	452, 3.5
$D_y$		18.5	10	28.6	27	22
$\delta_{BS}$	%	2.2	1.8	2.4	5.7	7
$\sigma_z$	$\mu\text{m}$	300	150	500	200	150
$P_{beam}$	MW	11	11	11	5.3	11
$Lumi$	$10^{34}$	2	2	2	2	

Tor Raubenheimer ALCPG meeting, 5<sup>th</sup> Oct 2006

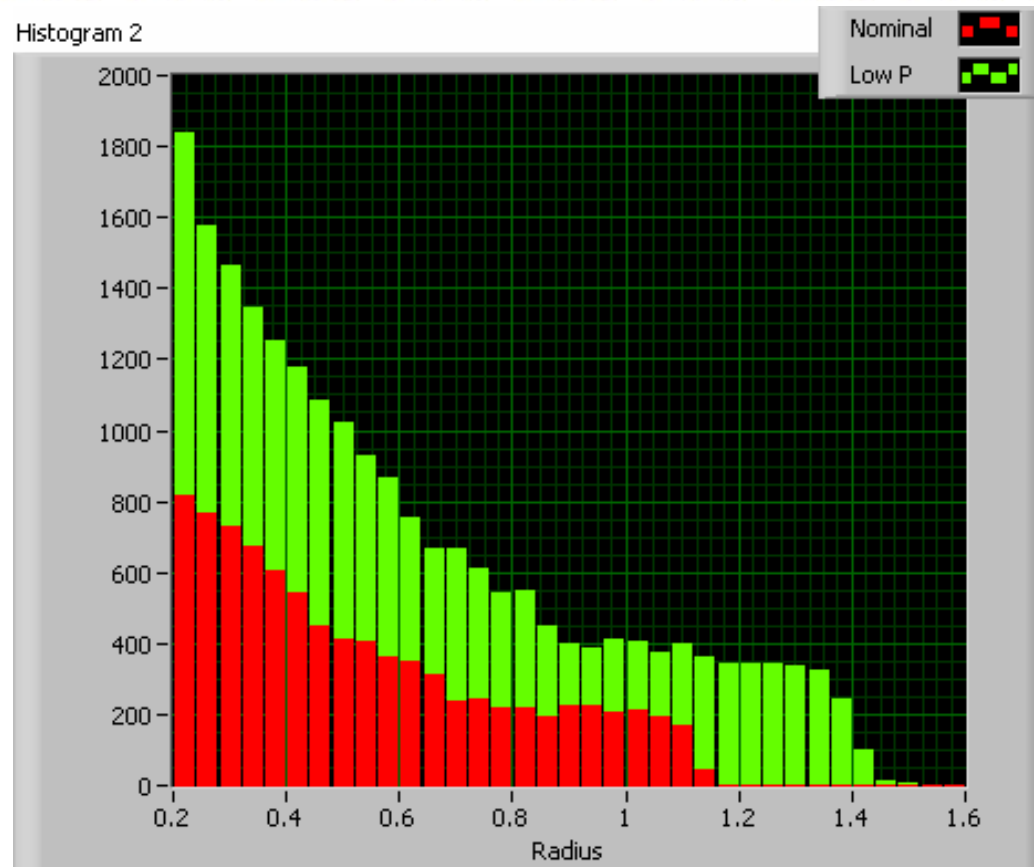
- ‘Low P’ is an association of two independent changes from the nominal design:
  - 2820 → 1330 bunches/train
  - Reduced  $\beta^*$  (factor 2 in both x and y) and reduced bunch length
- The first change halves the number of klystrons and provides a cost saving of 2-3%
- The second restores the luminosity to  $2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$  at the cost of:
  - increased energy spread (ave E-loss 2.2% → 5.7%)
  - increased beamstrahlung/pair production, pushing the beampipe to larger radius
- This procedure to increase **L** could be applied to the nominal parameters (it is approximately the High L option), so it should be considered on its merits

- Pair production for these and other options was presented at Snowmass 2005 by Cécile Rimbault, and published in Phys.Rev.ST Accel.Beams 9:034402,2006





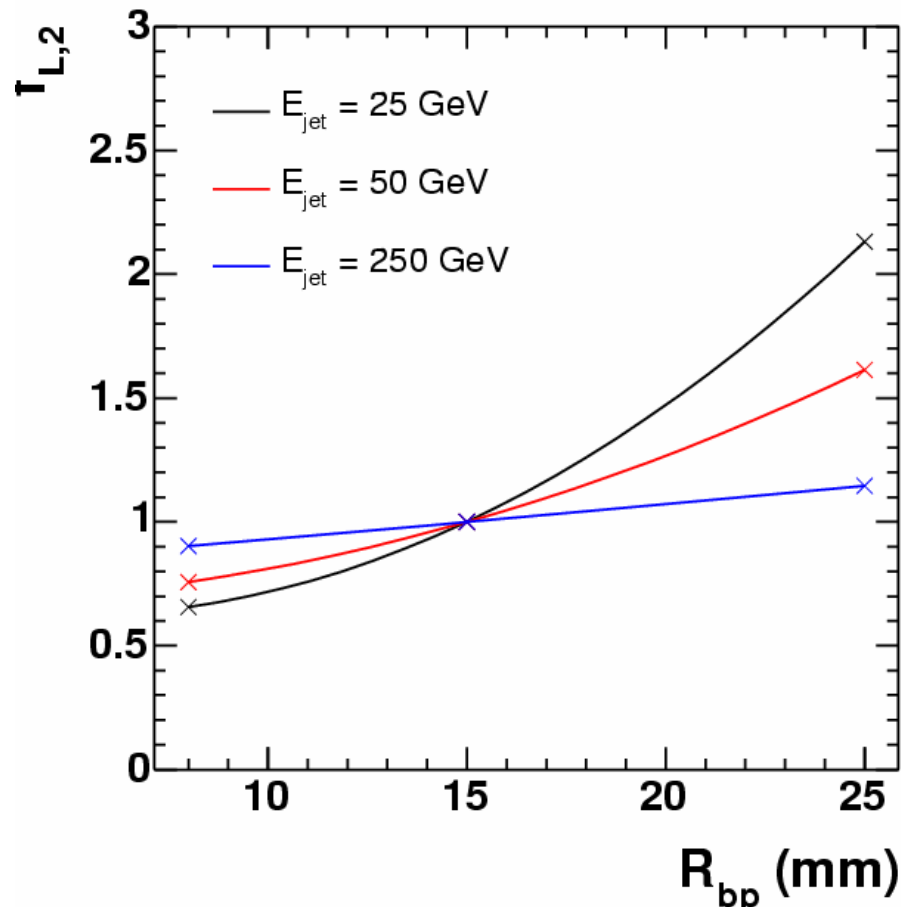
- Nominal and low P, 4 T,  $|z| = 8$  cm
- CAIN simulation, 1 bunch, 64k electrons (nominal), 159k electrons (low P)
- **Very preliminary** results from Tim Woolliscroft (Liverpool U)
- Interesting to see the deviations from azimuthal symmetry in the pair envelope at the end of the cylindrical pipe



- **Nominal and low P, 4 T,  $|z| = 8$  cm, radial distribution (cm)**
- **If  $R_{bp}(\text{min})$  is 15 mm for nominal FF (stable since Obernai, 1999, Nick Walker), this suggests we need  $R_{bp} \sim 18$  mm for low P**



## 2-jet luminosity factors



Plot shows the ‘irreducible limit’ from low momentum tracks ambiguous between IP and decay chain

$R_{min}$  for layer 1 depends on which technology will work ( $\sim R_{bp}$  for chronopixels, larger for other options)

Radius limit for time integrating detectors comes from hit density on layer 1:

[tracks fitted to layer 2 having unacceptable level of ambiguous hits within the extrapolated ellipse on layer 1]

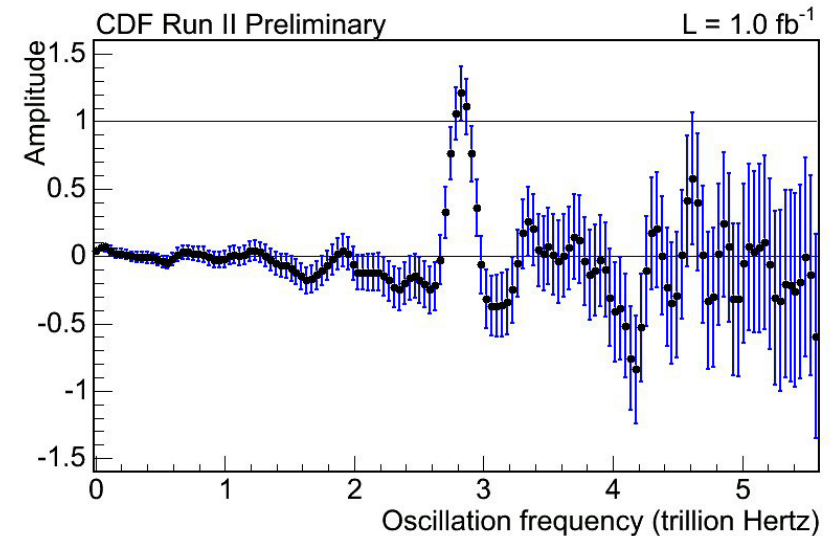
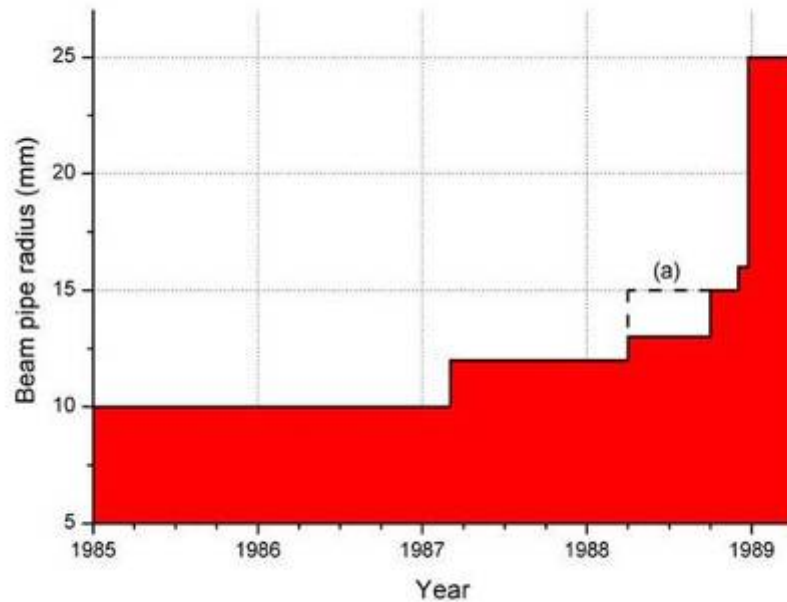
These limits will be evaluated by the ILC vertexing community with full M/C simulation and reconstruction, for different assumed technologies

**Largest uncertainty by far: which technology can be made to work without creating a small furnace at the heart of the ILC detector?**

*This may not be known for 2-3 years. For  $\sim 50 \mu s$  sensitive time,  $Nom \rightarrow Low P$  inflates Layer 1  $R_{min}$  16  $\rightarrow$  24 mm*



# Consequences of a swelling beampipe!



*CDF's beautiful result – Sept 2006*

Some will see increasing  $R_{bp}$  as 'progress'. However, this cost SLD the measurement of  $B^0_s$  mixing, who knows what further physics, and delayed the mixing measurement by 8 years. Similar story from LEP ...





## Interim Conclusions

- Advantage of factor 2 luminosity gain for low  $\beta^*$  option is roughly cancelled for processes where vertex charge for moderate energy jets is required, for detectors with timing resolution  $\sim 50 \mu\text{s}$
- Increased energy spread will further weaken this option for some physics processes
- However, for physics that requires neither of these, this luminosity gain will be useful
- How to decide? Maintain flexibility; maybe LHC results will provide guidance ...
- Our opinion: processes such as  $e^+e^- \rightarrow t \bar{t} \nu \bar{\nu}$  *will* be important at ILC
- **Independent of  $\beta^*$ , let's hope that the penalty in ILC luminosity by factor 2, for 2-3% cost saving, can be avoided by the international community**